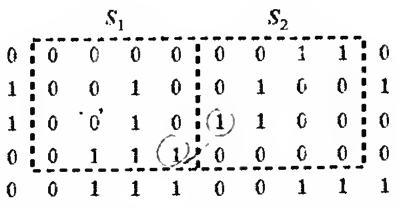
Sheet 3

1. Determine if each of the following statements is true or not. If it is not, modify it to become true.
   a) When the acquisition of an image is done using a single sensor both x and y dimension resolutions are controlled by the precession of mechanical movement
   b) When the acquisition of an image is done using a sensor strip both x and y dimension spatial resolutions are controlled by the precession of mechanical movement
   c) If two pixels are 8-adjacent then they are 4-adjacent
   d) The pixels having a D_4 distance from (x , y) less than or equal to some value r form a circle centered at (x, y)
   e) Gama ray imaging are typically used in exploring minerals and oil.
   f) In digital image processing, decreasing the contrast decreases the dynamic range of the image.
   g) Nearest neighborhood interpolation gives better results than bilinear interpolation when dealing with digital images.

2. High-definition television (HDTV) generates images with 1125 horizontal TV lines interlaced (where every other line is painted on the tube face in each of two fields, each field being 1/60th of a second in duration). The width-to-height aspect ratio of the images is 16:9. The fact that the number of horizontal lines is fixed determines the vertical resolution of the images. A company has designed an image capture system that generates digital images from HDTV images. The resolution of each TV (horizontal) line in their system is in proportion to vertical resolution, with the proportion being the width-to-height ratio of the images. Each pixel in the color image has 24 bits of intensity resolution, 8 bits each for a red, a green, and a blue image. These three "primary" images form a color image. How many bits would it take to store a 2-hour HDTV movie?
(Problem 2.10, Digital image processing, Gonzalez and Wood, 3ED)

3. Consider the two image subsets: S_1 and S_2, shown in the following figure. For V = {1}, determine whether these two subsets are
   (a) 4-adjacent
   (b) 8-adjacent
   (c) m-adjacent



(Problem 2.11, Digital image processing, Gonzalez and Wood, 3ED)

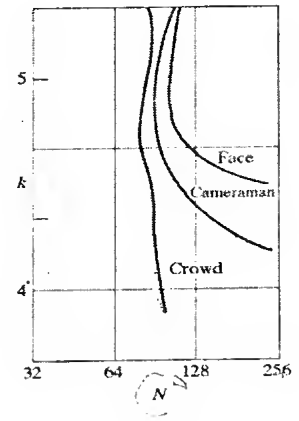
4. Consider the image segment shown below.
   a) Let V = {0, 1} and compute the lengths of the shortest 4-, 8-, and m-path between p and q. If a particular path does not exist between these two points, explain why.
   b) Repeat for V= {1, 2}.

3	1	2	1(q)
2	2	0	2
1	2	1	1
(p) 1	0	1	2

(Problem 2.15, Digital image processing, Gonzalez and Wood, 3ED)

5. Discuss three different representations of digital images. Show the context in which each of the three representations is used

Report 6. What do you understand from the following *isopreference* curves (shown below) for three types of images: Low details images represented by a face image, Medium details images represented by a camera-man image and high details images represented by a crowd image.



Sheet # 3

Q 3.1 : Determine if each of the following statements is true or not. If it is not, modify it to become true.

a) "When the acquisition of an image is done using a single sensor both x and y dimension resolution are controlled by the precission of mechanical movement" (True)

b) "When the acquisition of an image is done using a sensor strip both x and y dimension spatial resolution are controlled by the precission of mechanical movement" (False)

⇒ The true statement :
"When the acquisition of an image is done using a sensor strip one dimension spatial resolution (along the sensor or the strip) is controlled by the number of the sensors on the strip. The other orthogonal dimention spatial resolution is controlled by the precission of the mechanical movement.".

c) If two pixels are 8-adjacent then they are 4-adjacent (False)

⇒ The true statement :
If two pixels are 4- adjacent, they are 8-adjacent.

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(d) The pixels having a D_4 distance from (x,y) less than or equal to some value r from a circle centered at (x,y). (False)

⇨ The true statement:
The pixels having a D_4 distance from (x, y) less than or equal to some value r from a diamond centered at (x,y).

(E) Gamma ray imaging are typically used in exploring minerals and oil. (False)

⇨ The true statement:
Images generated by low frequency sound waves are typically used in exploring minerals and oil.

(F) In digital image processing, decreasing the contrast decreases the dynamic range of the image (True).

(G) Nearest neighborhood interpolation gives better results than bilinear interpolation when dealing with digital images (False)

⇨ The true statement:
Bilinear interpolation gives better results than nearest neighborhood interpolation when dealing with digital images.

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Q 3.2 High-definition television (HDTV) generates images with 1125 horizontal TV lines interlaced (where every other line is painted on the tube face in each of two fields, each field being 1/60th of a second in duration). The width-to-height aspect ratio of the images is 16:9. The fact that the number of horizontal lines is fixed determines the vertical resolution of the images. A company has designed an image capture system that generates digital images from HDTV images. The resolution of each TV (horizontal) line in their system is in proportion to vertical resolution, with the proportion being the width-to-height ratio of the images. Each pixel in the color image has 24 bits of intensity resolution, 8 bits each for a red, a green, and a blue image. These three "primary" images form a color image. How many bits would it take to store a 2-hour HDTV movie?
(Problem 2.10, Digital image processing, Gonzalez and Wood, 3ED)

Given:

- The movie is carried out by taking a frame (image) every $\frac{2}{60}$ seconds. $\Rightarrow$ (30) image in second

- The no. of vertical lines in the image is $\frac{16}{9}$ of the no. of horizontal lines.

∵ no. of horizontal = 1125 line

∴ no. of vertical lines $= \frac{16}{9} * 1125 = 2000$ line

∴ The no. of images of 2-hour movie $= 2 * 60 * 60 * 30$
$= 216000$ image.

- The no. of pixels in one image = no. of vertical * horizontal
$= 2000 * 1125 = 2250000$ pixel.

∴ The no. of bits to store one image $= 2250000 * 24$
$= 54000000$ bit

∴ The no. of bits need to store the movie =
$= 216000 * 54000000$
$= 1.1664 * 10^{13}$ bit

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Q 3.3 : Consider the two image subsets : S_1 and S_2, shown in the following figure. For $V = \{1\}$, determine whether these two subsets are :

(a) 4-adjacent

(b) 8-adjacent

(c) m-adjacent

	S_1				S_2				
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	1	1	0	0	0
0	0	1	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

Let p and q as shown below.

	S_1				S_2				
0	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	1	0	0	1
1	0	0	1	0	(1) q	1	0	0	0
0	0	1	1	(1) p	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1

(a)

S_1 and S_2 are not 4-Connected because q is not in the set $N_4(p)$.

(b)

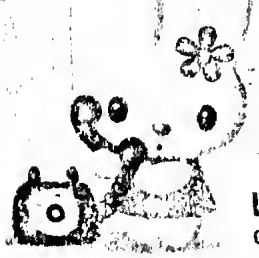
S_1 and S_2 are 8-Connected because q is in the set $N_8(p)$.

(c)

S_1 and S_2 are m-Connected because :

① q is in $N_D(p)$

② the set $N_4(p) \cap N_4(q)$ is empty.



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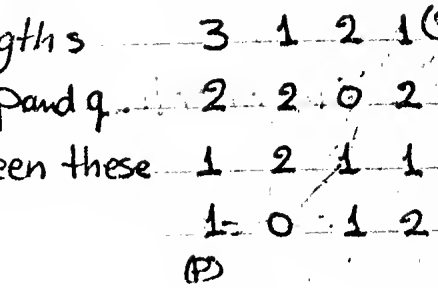
Q 3.4 : Consider the image segment shown

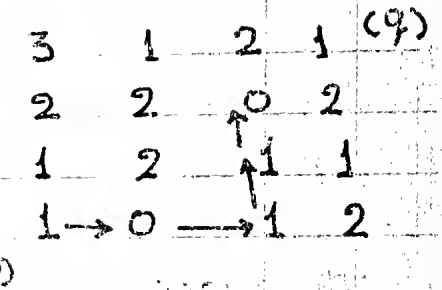
a) Let $V = \{0, 1\}$ and compute the lengths of the shortest 4, 8, m-path between p and q. If a particular path does not exist between these two points, explain why?

b) Repeat for $V = \{1, 2\}$

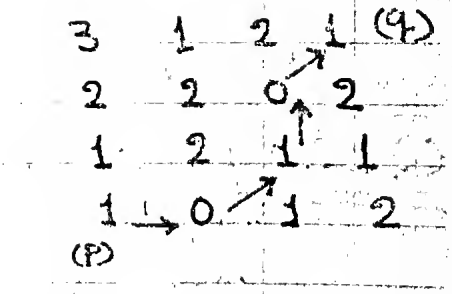


(a) When $V = \{0, 1\}$

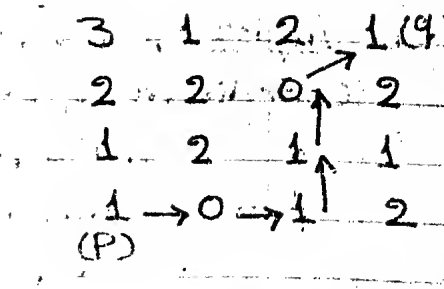
4-Path does not exist between p and q because it is impossible to get from p to q by travelling along points that are both 4-adjacent and also have values from V



- The shortest 8-path has length 4

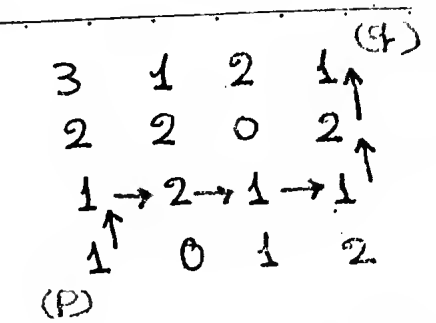


- The shortest m-Path has length 5

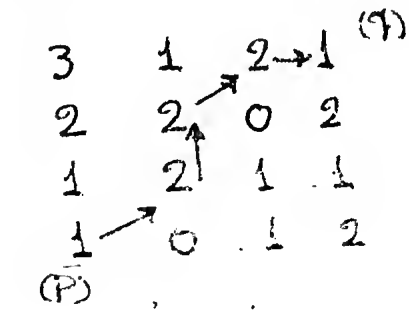


(b) $V = \{1, 2\}$

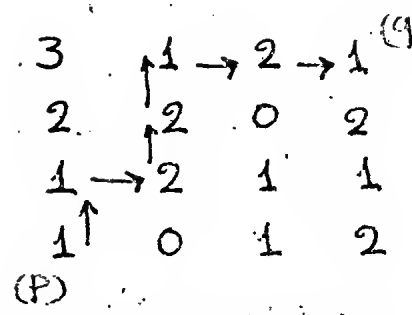
- The shortest 4-Path has length = 6



- The shortest 8-Path has length = 4



- The shortest m-Path has length = 6

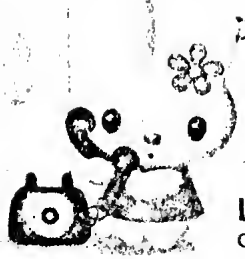


Q 3.5: Discuss three different representations of digital images. show the context in which each of the three representations is used?

(1) A plot of the function $f(x,y)$ in a 3-dimension Cartesian Coordinate system.

- The first two axis (x and y) are spatial Coordinats
- The third axis is the intensity value as a function of x and y.

⇒ useful when working with grayscale sets and adjacency.



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(2) A 2D plane (the common one) where the intensity of the intersection of the spatial coordinate is determined by the value of $f(x,y)$
- As we see in a photograph and the monitors.

⇨ useful in visual inspection.

(3) The matrix form : it has number of rows and columns determined by the spatial dimensions of the image.
- The value of the matrix at the indices x and y is the intensity value at that location in the image.

⇨ useful when dealing with images mathimatically.

Q 3-6 : Report.

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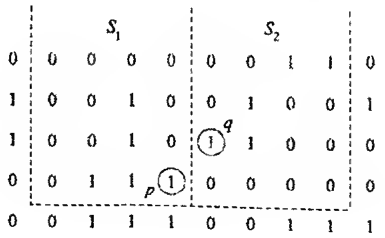
Sheet 3 solution

1.

Item	answer	The true statement if False
A	T	
B	F	When the acquisition of an image is done using a sensor strip One dimension spatial resolution (along the sensor on the strip) is controlled by the number of the sensors on the strip. The other orthogonal dimension spatial resolution is controlled by the precession of the mechanical movement
C	F	If two pixels are 4-adjacent, they are 8-adjacent
D	F	The pixels having a D4 distance from (x , y) less than or equal to some value r form a diamond centered at (x, y)
E	F	Images generated by low frequency sound waves are typically used in exploring minerals and oils
F	T	
G	F	Bilinear interpolation gives better results than nearest neighborhood interpolation when dealing with digital images

2. The movie is carried out by taking a frame (image) every (2/60) seconds. The number of vertical lines in the image is (16/9) of the horizontal lines, but the number of horizontal lines in the image=1125 line, so the number of vertical line is (16/9)*1125. The number of images for 2-hour movie = 2*60*60*30 = 216000 image. The number of pixels in one image = 1125*(16/9)*1125= 2250000 pixel. The number of bits need to store one image= 2250000*24=54000000 bit. The number of bits need to store the movie = 54000000*216000= 11664000000000 bit

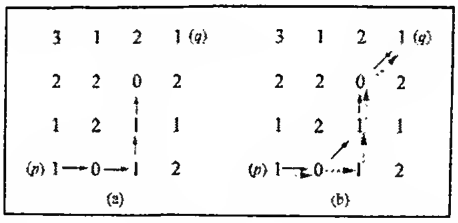
3. Let p and q be as shown below. Then, (a) S_1 and S_2 are not 4-connected because q is not in the set $N_4(p)$; (b) S_1 and S_2 are 8-connected because q is in the set $N_8(p)$; (c) S_1 and S_2 are m-connected because (i) q is in $N_D(p)$, and (ii) the set $N_4(p) \cap N_4(q)$ is empty.



4. (a)

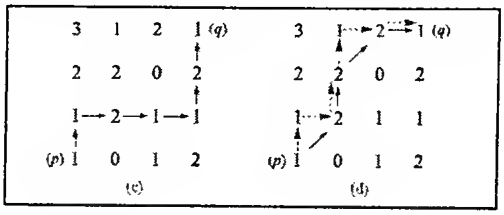
When $V = \{0, 1\}$, 4-path does not exist between p and q because it is impossible to get from p to q

by traveling along points that are both 4-adjacent and also have values from V. Figure (a) below shows this condition; it is not possible to get to q. The shortest 8-path is shown in Figure (b) below; its length is 4. The length of the shortest m- path (shown dashed) is 5. Both of these shortest paths are unique in this case.



(b)

All paths exist and are shown in figures c and d below. 4-path length is 6, 8-path length is 4 and the m-path length is 6.



5. The first representation is a plot of the function f(x, y) in a three dimension Cartesian coordinate system. The first two axes (x and y) are the spatial coordinates and the third axis is the intensity value as a function in the two spatial variables x and y. these representation is is useful when working with gray scale sets and adjacency.
   The second representation is the common one. It's the representation of the image in a 2D plane where the intensity of the intersection of the spatial coordinate is determined by the value f(x, y). This is the form we see in a photograph and on the monitors. Clearly this representation is useful in visual inspection.
   The third representation is the matrix form. A matrix that has number of rows and columns determined by the spatial dimensions of the image represents the image. The value in the matrix at the indices x and y is the intensity value at that location in the image. This representation is useful when dealing mathematically with the image.

6. For low details images (faces), the subjective quality remains the same while decreasing spatial resolution and increasing the intensity resolution, of course to a certain limit. The same thing could be said about medium details images (camera man). This means that the inadequate visual quality due to the insufficient resolution in one of the two (spatial or intensity) can be compensated by increasing the other. The validity of this relation depends on the amount of details in the image. This is clear if we look at the curve of the height details images, it's nearly vertical. This means that as the level of details increases in a scene, as the range of spatial resolutions in which we can sample this scene become narrower.